4

MATHEMATICS WITH/IN MUSEUMS
LONDON, PARIS, NEW YORK*

ΤΑ ΜΑΘΗΜΑΤΙΚΑ ΜΕ/ΣΤΑ ΜΟΥΣΕΙΑ
ΛΟΝΔΙΝΟ, ΠΑΡΙΣΙ, ΝΕΑ ΥΟΡΚΗ

Anna Chronaki / Άννα Χρονάκη

ΠΕΡΙΛΗΨΗ

Τα τελευταία χρόνια παρατηρούμε ένα αυξανόμενο ενδιαφέρον για την δημιουργία μουσειακών εκθεμάτων, για την παραγωγή μουσειο-παιδαγωγικού υλικού, για την οργάνωση συλλογών τεχνουργημάτων ή αντικειμένων, για την επιμέλεια εκθέσεων, αλλά και για την ίδρυση νέων μουσείων αφιερωμένων στα μαθηματικά και στους κόσμους που τα περιβάλλουν. Ένας τέτοιος φλέγων ενθουσιασμός, αν και συχνά βασισμένος σε καθομολογημένες επιθυμίες και παλαιές πρακτικές μιας ρομαντικής ματιάς στην επιστήμη, μπορεί να συσχετισθεί με την κατανόηση των μουσείων ως χώρων για την αναδιαπραγμάτευση, και, ίσως, την ανασυγκρότηση της επιστημολογικής φύσης των μαθηματικών ιδεών καθώς και των ταυτοτήτων, των ιστοριών και των γεωγραφιών που τις προσδιορίζουν. Όμως, το μουσείο αυτό καθ' αυτό, όπως κάθε κοινωνικός και κοινοτικός χώρος σχεδιασμένος συστηματικά για να παρουσιάσει, να αναπαραστήσει, να διαμοιράσει, να διαδώσει, να μεταφέρει και να επικοινωνήσει πληροφορία, γνώση, πολιτισμικά εργαλεία και υλικά αντικείμενα δεν μπορεί να ιδωθεί ως χώρος ενικός, ουδέτερος και α-πολίτικος. Η εμπειρία μιας βιωματικής σχέσης με τους εν εξελίξει λόγους και πρακτικές που αφορούν το μουσείο και τον ρόλο του στην κοινωνία ως εναλλακτικού τόπου παιδαγωγικής και μάθησης απαιτεί την αναλυτική και κριτική ενασχόλησή μας με διαδικασίες που μας υποστηρίζουν να ξανασκεφτούμε την σημασία και το νόημα των επιμέρους εκθεμάτων, των συλλογών, του κοινού, της γνώσης, της πληροφορίας, των υλικών, των υποκειμένων και της μεταξύ τους αλληλεπίδρασης.

Anna Chronaki is Professor in *Learning Technologies and Mathematics Education*, Department of Early Childhood Education, School of Humanities and Social Sciences, University of Thessaly, Volos, Greece.
chronaki@ece.uth.gr

Museumedu 1 / May 2015, pp. 89-113.

Έχοντας τα παραπάνω κατά νου, το παρόν κείμενο αποτελεί μια προσπάθεια συζήτησης, μέσω της εστίασης σε τρεις περιπτώσεις μουσείων τα οποία υιοθετούν τα μαθηματικά και τα οποία εδράζουν στις τρεις μητροπόλεις του Λονδίνου, του Παρισιού και της Νέας Υόρκης, των πολλαπλών τρόπων που η ιδέα 'μαθηματικά με/στα μουσεία' ξετυλίγεται, εκφράζεται, παρουσιάζεται και, τελικά, μοιράζεται με το ευρύ κοινό. Την ίδια στιγμή, αποτελεί ευκαιρία να διερευνηθεί πως η επίσκεψη σε ένα μουσείο ως φυσικό ή δυνητικό γεγονός παράγει συγκινήσεις οι οποίες υποστηρίζουν την επανεξέταση και, πιθανότατα, την ανασυγκρότηση της εικόνας των μαθηματικών ως κοινωνικό και υλικό αγαθό, των μαθηματικών αντικειμένων, των μαθηματικών διαδικασιών και των μαθηματικών υποκειμενικοτήτων.

Η **Άννα Χρονάκη** είναι Καθηγήτρια *Μαθησιακής Τεχνολογίας και Μαθηματικής Εκπαίδευσης* στο Παιδαγωγικό Τμήμα Προσχολικής Εκπαίδευσης, Σχολή Ανθρωπιστικών και Κοινωνικών Επιστημών, Πανεπιστήμιο Θεσσαλίας, Βόλος. chronaki@uth.gr

ABSTRACT

A growing interest is witnessed, during the last decade, in the production of museum exhibits or displays, the collection of artefacts, the curation of museum exhibitions and the establishment of entirely new museums dedicated to mathematics and its worlds. Such a renewed enthusiasm, although based on avowed desires and aged practices, can be positioned on the burgeoning significance of museums as spaces for renegotiating and, even, reconstructing the epistemic status of mathematical ideas as well as their identities, histories and geographies. But, the museum itself, as any social or community space designed towards presenting, representing, disseminating, spreading, conveying and communicating information, knowledge, cultural artifacts and material objects, cannot be seen as singular, neutral and apolitical. The increased awareness of the developing discourses concerning the museum itself and its role in society as an alternative space for pedagogy and learning requires us to engage into rethinking about the significance of exhibits, collections, audiences, knowledge, materials, subjects and their integration. Considering the above, the present paper consists an attempt, by means of focusing on three diverse cases of museums that embrace mathematical ideas and are located at the metropolis of London, Paris and New York, to discuss the multiple ways through which the idea of 'mathematics with/in museums' unfolds and becomes expressed, presented and shared out in the public. At the same time, it provides an opportunity to explore how a physical or a virtual visit to the museum produces affect and affective experiences that may lead, virtually and potentially, into a revisiting and, possibly, reforming of the socio-material images of mathematics, mathematical objects, mathematising processes, and mathematical subjectivities.

Introduction

London, Paris and New York have neither stopped being amongst the desired destinations of bourgeoisie, immigrants or subalterns nor halted being realized as the major centres of cosmopolitanism, multiculturalism and alterity worldwide. What happens in these three mythical cities signifies what can be considered as the current trend of innovation in culture and technology, the avant-garde of the arts, the gist of life, the struggle to voice the margins and the marvels of contemporary thinking. At the same time, these specific urban terrains have never ceased being the hub where a multiplicity of cultures, civilizations, social groups, epistemic communities, artists, scientists, craftsmen and activists seek shelter, grow through political battles, resist colonialism or domestic oppression and create paths that move them (and us all) into new trajectories. The museum, in each one of these metropolis, and nowadays in every city, has marked a crucial part in the politics of collective memory and identity work. The museum becomes the place where images of the 'self' and the 'other' can be archived, filed, preserved, exhibited, displayed, negotiated, sustained, troubled, provoked and possibly transformed.

It is not the purpose of the present text to elaborate on the manifold role played by the museum into re-imagining the city or the nation and re-considering its urban terrain in contemporary capitalist economy, or even into re-thinking museum education, pedagogy and learning –a task beyond our scope. Instead, this paper focuses on some marginal, yet critical, moments in the life of three cities that relate to three distinct cases of museums where mathematics as a museum exhibit finds dwelling. The choice of these three cases is not accidental. Instead, it notifies *first,* the significance of spatiality in terms of the museum space itself as an architectural venture to host 'mathematical ideas' and its positioning in a specific urban locality, *second,* the implications of particular exhibits or exhibitions towards sensing, experiencing and imagining mathematical concepts or processes, and *third,* the influence of such experiences in the vicinity of constructing, reconstructing or even presenting fragments of social images concerning mathematics and its material relation to our physical, social and humane environment.

In line with this threefold task, the choice to focus on the cases of an exhibition, an exhibit and a collection of mathematical objects in the three well known museums, of Tate Modern in London, the Musée de l' Homme in Paris and the MOMATH in New York, epitomizes three diverse ways of anchoring mathematical ideas and, equally, three distinct ways of applying the idea of '*mathematics with/in the museum'*. The purpose, here, becomes, then, to open up a discussion of what does it mean to visit museums and, simultaneously, to re-visit our dispositions with mathematics and mathematical subjectivity. Towards this, the recent exhibition of Topology at Tate Modern in London

in year 2011-12, the 19th century exhibit of 'Hottentot Venus' in Musée de l'Homme in Paris and the monumental collection of mathematical displays at the newly established museum of MOMATH in New York have been deliberately considered for further interpretation whilst each case is recounted and deciphered as a brief narrative[1].

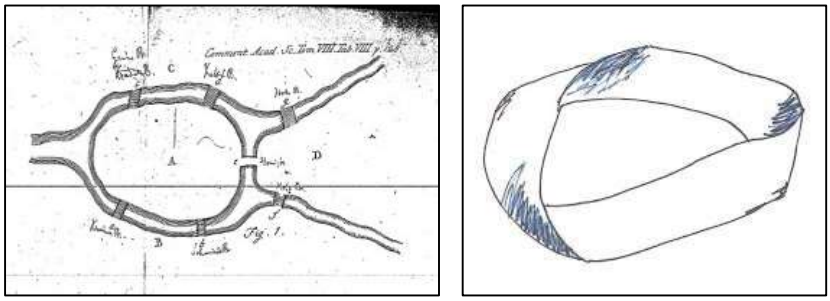
Topology as a transdisciplinary event. Tate Modern, London 2011

On Saturday, the 5th of November in the year 2011, Tate Modern at Bankside in South East London, opens its doors and hosts the curation of a cluster of events unified into a seven month exhibition under the theme "Topology". This museum exhibition is the outcome of an international and interdisciplinary collaboration amongst several experts in fields as diverse as philosophy, mathematics, arts, sociology, geography, choreography, social theory, psychoanalysis and critical psychology. Renowned contemporary philosophers, leading intellectuals and artists such as Étienne Balibar, Drucilla Cornell, Catherine Malabou, Bruno Latour, Nigel Thrift have been invited to become part of the Topology project. This team of theorists has joined forces and energies with creative practitioners towards identifying expressive and innovative ways for making concepts, histories and geographies of 'topology' accessible and available in transformative ways. The Topology exhibition has been curated by Jean Matthee (artist), Bernard Burgoyne (psychoanalyst), Marko Daniel (curator), Julian Henriques (critical psychologist), Celia Lury (cultural theorist) and Brian Rotman (mathematician) –a team with a deep interest in notions of space, spatiality, topology and transdisciplinarity.

Pictures 1, 2: Tate Modern, Bankside, London.

Topology, originating from the Greek words "τόπος" and "λόγος", is the official term used as reference to the well-known theory of space that emerged in the 17th century. The work of a number of mathematicians, including Leibniz in the 17th century, Euler in the 18th or Poincare and Cantor in the 19th, envisioned topology as the geometry of place and space. As early as 1736, Leonard Euler was heavily involved in providing a

solution to the topology problem of the Seven Bridges of Königsberg –a city in Prussia. The city was set on both sides of the Pregel River that included two large islands which were connected to each other and the mainland by seven bridges. The problem was to find a walk through the city that would cross each bridge once and only once. Euler proved that the problem has no solution. More than a century after, in year 1858, the Möbius strip or Möbius band, named after its discoverer the mathematician August Ferdinand Möbius, made its appearance. The strip has attracted significant attention as its topology can be realized as a 'non-orientable' but, yet, a well 'ruled surface' (see Pictures 3, 4).



Pictures 3, 4: The Seven Bridges of Königsberg and the Möbius Strip.

By the middle of the 20th century, topology had eventually become a major branch of mathematics involved into understanding and characterizing the spatial properties of connectedness and invariance under transformation. This particular disciplinary area, as most areas in mathematics, started with a detailed consideration of the physical environment and has proceeded rapidly into developing certain genres of mathematising that evolve into highly abstract and symbolic language. As such, the physical, social and technical entities of the space dissolve into becoming algorithms and diagrammatic relations that capture what seems ungraspable by bare sight in the sheer complexity of space and spatiality. At the same time, they produce conceptual images that fascinate and excite the imagination of not only mathematicians but also scientists, visual artists and designers (see Picture 3).

Pictures 5, 6: Topology turned into Art.

Although topology might work, for the non-mathematician, as an esoteric domain of knowledge, the curators of "Topology" exhibition argue that its conceptual language develops into ideas, notions and words such as "*…limit, boundary, interior, exterior, neighbourhood, disconnection and cut*" that turn to influence the language of contemporary cultural theory, philosophy, anthropology, arts, choreography or geography. But, what is essential here is that this particular exhibition does not rest into presenting an epistemic area such as topology in static terms. On the contrary, it places efforts into an alternative narrative that concentrates on how mathematicians themselves have re-constructed the idea of space as 'container' into the idea of space as 'movement', 'transformation', 'differentiation', 'inclusion' and 'exclusion'. And, in fact, they did so well before social theorists became engaged with these conceptual ideas as social constructs for their analysis of issues related to power, positioning, translocality, transfer, transformation, change. The curating team continues by emphasizing the powers of topology and explain that

> [w]ithin a few years of its inception, psychologists, psychoanalysts, architects, artists, scientists and philosophers had started to use the conceptual language of relationships, intensities and transformations of this new theory outside of the field (Topology 2011-2012: 2).

Pictures 7, 8, 9, 10: Topology Exhibition: Routes, Borders, In-Between.

Contrary to any mainstream view by which the public at large, including visitors of Tate Modern and spectators of this particular exhibition, approaches mathematics as an abstract, pure and decontextualized field of knowledge, the curators here denote how mathematics travels across disciplinary fields and bridges conceptual territories in philosophy, psychoanalysis, critical theory and the arts. They suggest mathematics as a language that involves not merely the mind, but, equally, the body, the senses, the sensations and the feelings. They claim that despite the myth of 'mathematics' being a certain code that speaks only to those who have been initiated to its semiotic and cultural genre, mathematical register provides an inspiring and conceptual language that enables the envisioning and materializing of complex ideas. Giles Deleuze explains that even though arts, philosophy and sciences are distinct in their ways of analysing reality and embodying creativity, none of these disciplines can enjoy primacy over the other. Instead, he argues that their *"separate melodic lines"* need to be *"in constant interplay with one another"* (Deleuze 1995: 125). Indeed, the heart of this transdisciplinary team's endeavours into delivering this exhibition on Topology has been the uncovering of this *interplay* – an interplay realized as a constant dialogic relation amongst sciences and arts.

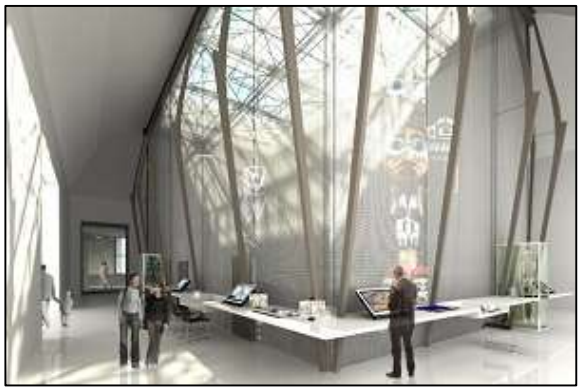
The Topology exhibition has been organized around a series of events that include talks and lectures, performances, installations and a conference. The talks and lectures involve a number of topics under the theme of 'spaces of transformation' such as; borders, continuity/infinity, epistemologies of the south, the vast space-time of revolutions becoming, mathematics as a beautiful elsewhere and spatialized immunity. Keynote conversations with leading intellectuals, artists and writers are organised to think over the crucial question "*How are the new topological spaces of globalization open to intervention and creativity?*" Next to the intellectual endeavours of theorists to capture contemporary concerns about urban space habitation through varied discourses of topology, the curators organized a performance program under the theme of 'embodying transformation'.

Two performances took place in this performance program, the *Ordinal 5* and the *Knots and donuts* where sound and movement were utilised to experiment with space creation. *Ordinal 5* is a space-sound choreography conceived by mathematician Brian Rotman and choreographed by Jeanine Thompson. Sound became spatialized around dancers and the audience through physical movement based on the mathematical entity of ordinal number 5^2 and the idea of ordinal numbers as described in set theory by George Cantor. *Knots and donuts* was an immersive sound sculpture, conceived by Julian Henriques, and explored the relation amongst sound and the topological entities of knots and torus or donuts. The sound sculpture explored "auditory geometry" through a 3D Ambisonic system installed in a bordered space and created a Borromean knot and Torus^3 or donut. Specifically, it was focused on how people 'hear space' and

experience its acoustic qualities beyond the sense of vision –a senses based condition unavailable for the visually impaired. By spatialising sound (i.e. locating sound in specific spaces) and sonifying space (i.e. making space hearable), the participants need to become listeners of space and to engage into 'hearing' how sound waves travel and draw shapes, lines and dots. Being part of this sculpture the listener experiences sound by actively engaging his or her body-movement in space. Sound is, thus, realized as transforming in a series of geometrical shapes and spatial entities or relations that do not remain static but are found in a constant flux.[4] In the ambience of such experiences, space becomes realised as an affective experience through the participation of senses and sensations and through the body's capacity to act and respond and engage (see also de Freitas & Sinclair, 2014).

The body as an exhibit of mathematising. Musée de l'Homme. Paris, 1937

In year 1937, the remains of Sara Baartman's body, a young Khoisan woman also known as "Hottentot Venus", moved from the Musée d' Histoire Naturelle to the newly established Musée de l'Homme in Paris, where her corpse was kept as a singular specimen of humanity. Her skeleton and body cast stood side by side at case 33 exemplifying its perceived scientific value. As the new museum was devoted to displaying the considerable anthropological collections accumulated mainly by the French, Baartman's body and detailed accounts of her anatomy became an important object offered to Western thinking as empirical data and, thus, as valid material evidence for theorizing human evolution in a scientific manner.



Pictures 11, 12: Musée de l' Homme, Trocadéro, Paris.

Sara Baartman was brought to Europe in 1810 by Alexander Dunlop, an exporter of museum specimens from Cape, as an imperial collection item along with animals, flora and other commodities to be consumed in England. She was soon purchased by a man who invested on her to serve as an 'exhibit' in ethnological shows in London that took place in theatres, museums, circuses, fairs and freak shows. Her black female sexuality,

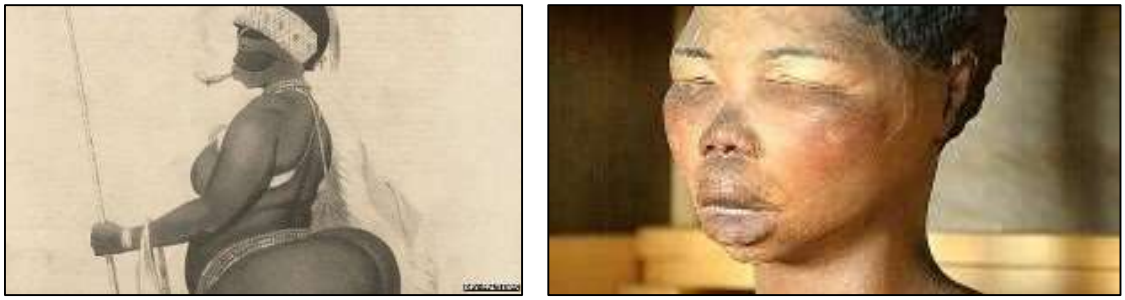
her steatopygia,[5] her colour, and her physical volume, as well as the public phantasies played around her African background, aroused immense curiosity and interest. Despite some humanitarian resistance that brought her case to the court, the ethnological or freak shows continued in London and other UK cities. In 1814, she came to Paris, after she was sold to an animal trainer, and was employed in similar shows. Being in Paris she had the peculiar experience of being asked to pose nude to the professors in the Musée d'Histoire Naturelle who wanted to observe systematically her body (see pictures 13, 14,15,16). Her body was kept at Musée d'Histoire Naturelle for more than a century, when in 1937 it was moved to Musée de l' Homme and stayed there before finally moving to her tomb in South Africa in year 2002. Her move to South Africa was the result of a campaign under the call '*Bring back the Hottentot Venus',* which begun in 1995. The campaign was a request to repatriate in South Africa the remains of a woman who assembled in her sole body an interplay of powers amongst gendered, racial, colonial and scientific biases and discourses.

Picture 13: The female body at the services of the scientist.

The representation of her naked young female body standing behind the shoulders of an old male scientist and next to the drawings of her genitalia signifies quite sharply her subject position as an object of the scientific method. Mathematising the body was, and still is, a common core scientific practice employed by scientists in a variety of specializations. Specific methods of mathematisation, also known as data handling, data analysis and data visualisation, become the tools towards a systematic and meticulous process to observe and capture the details of an empirical phenomenon (Jablonka 2010). Francis Galton[6] has provided one of the most memorable indications of mathematising on the Khoikhoi female body in an account of his visit to the Cape in 1851 well after Sara Baartman's death. Observing a Khoisian woman in the distance, as

indication of an attitude of both scientific curiosity and obsession with black sexuality, he writes about his efforts and trials to produce an image of her body:

> I profess to be a scientific man, and was exceedingly anxious to obtain accurate measurements of her shape; but there was difficulty … I did not know a word of Hottentot … I therefore felt in a dilemma as I gazed at her form, that gift of bounteous nature to this favoured race which no mantua-maker, with all her crinoline and stuffing, can do otherwise than humbly imitate. The object of my admiration stood under a tree, and was turning herself about to all of the compass, as ladies who wish to be admired usually do. Of a sudden my eye fell upon my sextant; the bright thought struck me, and I took a series of observations ... and registered them carefully upon an outline drawing for fear of my mistake; this being done, I boldly pulled out my measuring tape, and measured the distance from where I was to the place she stood, and having thus obtained both base and angles, I worked out the results by trigonometry and logarithms' (cited in Qureshi, 2004: 247).

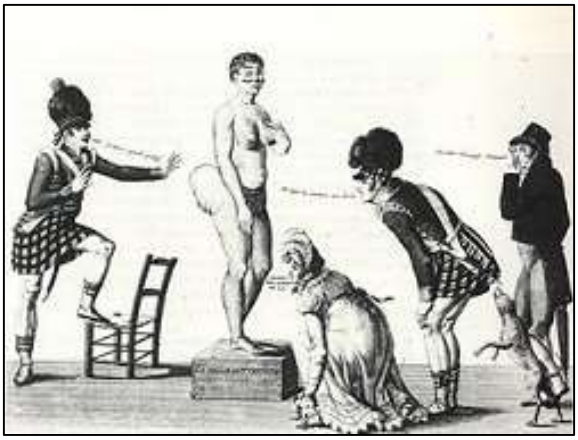


Pictures 14, 15: Hottentot Venus in Display.

Such a meticulous process of mathematising inscribed not only on the human body but equally on the skin of animals and the flesh of plants has functioned towards constituting theories about anatomy, physiology, votanology, zoology and, more recently, biology and biogenetics. However, mathematising is not a neutral process but deeply rooted in processes of both overt or subtle discrimination and exclusion. Such processes involve affects that release emotions of joy and pain, pleasure and shame, satisfaction and misery depending on the subject's positioning at the spectrum of colonized and colonizer, of scientist and scientific object or of theory and data as evidence. Specifically, Sara Baartman's body as a black Negro woman, as a Khoisan woman, as an exhibited woman, or, as a woman with steatopygia becomes the focal point of discourses upon race, gender and empire. At the same time, the practice of a systematic mathematization of her body concentrates the anxieties of the period to understand the evolution of humanity, to depict it in scientific terms and to produce narratives of what is known as 'scientific analogy' and 'scientific orientalism'.

Africans were historically placed next to primates in the great chain of being. Race and gender are also depicted by Nancy Leys Stepan (2000) as a powerful 'scientific analogy' that occupied a strategic place in scientific theorizing about human variation in the nineteenth and twentieth centuries. Remnants of this argument are found in examples from anthropometric, medical and embryological studies focused on measuring human and animal skeletons (see Gould, 1981). Such studies have provided evidence of women's low brain weights and deficient brain structures as compared to men from varied cultures or even to animals. Thus, it was observed that Woman shared with Negroes the primitive traits of a narrow, childlike, and delicate skull found in lower castes, so different from the more robust and rounded heads characteristic of the males of superior races. Evolutionary biology, making use of such evidence, provided the analogy of woman as the 'conservative' element to the man's 'progressive' nature (Ellis, 1926). Londa Schiebinger (2000) discusses the shameful case of 'Hottentot Venus' as an object of scientific inquiry in modern biology via a systematic mathematising of her body. As Schiebinger (2000) explains:

> In the spring of 1815 she was summoned to the Jardin du Roi by a commission of zoologists and physiologists, where she was examined for three days. Henri de Blainville, professor at the Museum d' Histoire Naturelle in the Jardin du Roi, set out his purposes in observing her: (1) to provide a detailed comparison of the woman with the lowliest race of humans (the Negro) and the highest type of apes (the orangutan); (2) to provide the most complete possible description of the anomalies of her genetalia. This investigation required that Sarah Baartman strip naked in the austere rooms of the museum in front of at least three formally dressed men (p. 29).



Picture 16: Caricature of mathematising Sara Bartmann.

Sara Baartman died nine months later from 'inflammation' at the age of twenty-six and her dead body was brought to the museum for further examination and display. Parts

of her body -like the many apes whose skeletons and skin were sold or donated to natural history museums- were preserved in formalin and became available for purchase as souvenirs in tiny bottles. In her case, gender traits, using black women as examples, were persistently invoked to evidence, not with words but through body mathematics, the racial superiority of mainly the white, middle-class man. In this way, the 'scientific analogy' transforms via mathematics into 'scientific orientalism'. Echoing Edward Said's orientalism that was used to refer to processes of eroticizing, labelling, and categorizing coloured women in ways that produced the perpetuation of closed hierarchies of human life and development. Said (1978) explained that the 'orient' occupied a gendered discursive position, since for centuries it was constructed by colonials as the inferior feminine other. Thus, the 'orient' needed to be studied, displayed, disciplined and civilized. Surprisingly, the human body could not serve the needs of both scientific analogy and scientific orientalism without mathematics, and specifically, the tools and strategies enabling a valid functional, supposedly a-political, use of mathematising. In April 2002, Sara Baartman's body was repatriated in her home in South Africa where thousands attended her funeral. African president Thabo Mbeki addressed her story as the story of the African people:

> …the story of the loss of ancient freedom … [and] of our reduction to the state of objects who could be owned, used and discarded by others (cited in Qureshi 2004: 251).

Playful collections of mathematical exhibits. MOMATH. New York 2012.

In December 2012 a new museum called MOMATH has been established and was ready to celebrate its opening at the north end of Madison Square Park in Manhattan –at the heart of New York and in the same area where MOMA, the much acclaimed Museum of Modern Arts stands. It was designed by a team of enthusiastic academic mathematicians chaired by Glen Whitney, a prior researcher in mathematical sciences, with an impetus to create a museum as *'a safe place to love math'* (Stewart and Skinner, 2012). The museum is wholehearted devoted to mathematics whilst some describe it as the North America's only math museum (see Behseta and Dunn 2015). It has been built as a response to the closing of the '*Goudreau Museum of Mathematics in Art and Science*' located on Long Island where it worked for almost two decades. Following Goudreau museum, the MoMath emanates as an innovative science or discovery centre specializing in mathematics, and within two years from its opening has managed to attract a huge number of visitors.[7]

The launching of MoMath was a matter of a broader complex social assemblage that included the construction of exhibits or displays, the collection of artefacts, the curation of exhibitions, and the cooperation with research institutes such as the Simon

Foundation[8] that has a strong focus on advancing research in the areas of science, mathematics, health and education. Playful museum artefacts, as will be seen in the examples below, have become the core of attention in the MoMath as they attract visitors of all ages. In addition, the museum organizes and schedules lectures, talks, seminars and conferences whose focus is to discuss latest theoretical and empirical projects in mathematical sciences as well as the contribution of mathematics in sciences, life sciences, arts, health and society.

Pictures 17, 18: MOMATH, Manhattan, New York.

The MoMath designers team have opted towards organizing an open and interactive space where all exhibits, displays, objects and exhibitions are purposefully built so that to become perceptible, tactile and embodied experiences for children and adults of all ages. Short and Peters (2014) explain that this new museum

> …is not filled with statues of famous mathematicians, or glass cases containing a dusty abacus. Instead, it is intended to be 'a kind of playground' that plays with geometry, art and algorithms (p. 14).

It is conceived as a next generation museum that focuses on the public understanding of basic and innovative ideas in the field of mathematical sciences. Glen Whitney argues in a recent interview to Sam Besheta and Michelle Dunn[9] that their commitment in MoMath is to offer mathematical objects and activities that are made accessible to a wider public and make sense to everybody. He claims that, while many people find mathematics abstract, decontextualised and fearful, the math museum is determined to manifest an experiential side of mathematics that is joyful, comprehensible, and accessible –a side that has the capacity to fascinate, inspire, involve and surprise.

With these in mind, the collections of mathematical exhibits and material objects are carefully designed and finely constructed so that to be elegant, surprisingly clever and approachable. Their conception is geared towards firing the visitor's curiosity of how things work and headed for advancing their motive into asking 'why?' One such example is the square wheeled bicycle as seen in pictures 19 and 20. A first sight of the

construction creates surprise as it might confront what some come to know about 'movement'. Both adults and children can have a personal go with biking in this system and experience how does it feel to use square wheels. This hands-on sensorial and somatic experience could, ideally, create the ground for children and adults to become seriously involved into asking questions of 'how' and 'why'.


Pictures 19, 20: The Squared Wheel Bike.

Embodied involvement, under certain circumstances where body and mind come in solidarity, could work hand-in-hand with theoretical pursuits towards providing explanations or interpretations of 'how things work'. But along the scope of theorizing mathematical norms, rules and patterns, embodied involvement results into affective experiences ending up with subjectively felt states of emotion. Patricia Clough (2008:2) explains the affect as '*pre-individual bodily forces augmenting or diminishing a body's capacity to act'* and as part of a political economy that instrumentally utilizes technologies, media and bodies into forging a new body, a new subject. Through these lenses, could we view the MoMath museum as an assemblage that strives to fabricate the child or the adult as the playful, joyful, curious, motivated, interested subject of mathematics? And if yes, what drives the investment in such a political economy? Who might be interested and why?


Pictures 21, 22: Tessellation Station.

But, let's turn into the museum exhibits again. Let's have a closer look on how elegant material exhibits are connected to abstract mathematics and try to unfold how the subject of mathematics is fabricated in this 'new' context. Although some basic aspects of mathematical theory become available next to each material display, the museum prioritizes personal bodily involvement with the mathematical exhibits without pushing into any extensive academic catechism. This is evident for the majority of mathematical artefacts including a large wall tessellation board –named the tessellation station (see pictures 21, 22). The board makes available specific colourful magnetic tiles which are there at hand, begging visitors to use them! Adults, children and even babies can hold these tiles and engage into composing full Escher-like ensamples in their own arbitrary and idiosyncratic ways. A simultaneous presence of simplicity and richness, easiness and complexity, feeling and knowing is what turns their immersive engagement with this exhibit into an experience that is synchronously affective and mathematical. Simultaneously, through their playful tactility that occurs in silence, without a major resorting to words or speech, essential skills related to spatial ability become practiced, exercised and sharpened.

Pictures 23, 24: Full Body Interactive Games.

Next to haptic and tactile constructions, where the use of hands become celebrated, there is emphasis on certain exhibits where interaction with the full body is required. As seen in pictures 23 and 24, but also in picture 25, such displays involve space sensitive games or interactive installations where specific body-movement effects, initiates and actualizes the rules of the game or the structure on which a particular installation works. Full body immersive games and installations involve the active of exploration of how bodies can be connected and related to the materiality of objects in the social, technical and physical environment. This happens because the objects are programmed so that to carry information through specific sensorial input/output that respond to any specific perceivable change (e.g. light, movement, sound). In fact, there

is synergy amongst the kinaesthetic technologies, afforded by body-movements, and the digital technologies, afforded by the inbuilt sensors in these exhibits. Hansen (2004) argues that digital media invite a new relationship amongst digital image and the body's sense of its movement, or *'affectivity'* in Brian Massumi's words (see Massumi 2002).

This is what Patricia Clough (2008: 2) theorizes as 'biomedia' referring to the 'technical frames' of a mediated body where genetic material and digital media *'make possible a profound technical expansion of the senses'*. In other words, the use of sensors along with the use of senses transmit the body's movement through an algorithmic code. The code turns the physical information into digital bits that by means of programming determine the behaviour of the system as a whole. Although the programming language embeds and hides the symbolic language of either simple or complex algorithms, the end user has just to enjoy the magic of the moment, to feel the excitement of gaining the system or to endure the powers of failing. Mathematics loses more and more its transparency as it is required to remain hidden and invisible within technologies that work through specific programming codes. As technology is committed to user-friendliness, mathematics is destined to stay covert. The fascination of magic returns.

Picture 25: Interactive Installation of Hyper Hyperboloid.[10]

One might wonder how such experiences could lead and advance the child or the adult to develop their mathematical subjectivity as genius, modest or critical learners, educators and players? What are the bodily capacities involved into such museum installations? How do they deal with the return of magic? And the disorder of logic, order and certainty? How do they serve to reconstruct images of the disappearance of

mathematics as these need to remain hidden, embedded and dissolved into such exhibits? It is apparent that what is required by children and adults as players is merely the high involvement of their bodily senses. No need to think, speak, ask, question or discuss. Just touch, feel and enjoy. Hansen (2004) argues that bodily affectivity or the body's capacity to act, to move and to sense forges the ways in which new media become part of human subjectivity since they aim to become part of every moment in daily life *"by tingeing or flavouring the embodied perceptual present"* (p. 605). And yet, whilst mathematics tends to disappear and dissolve within these haptic or digital constructions so that to serve the needs of a playful experience, one might attest how the discourses around playfulness are not neutral and a-political contexts. Instead, they sustain and perpetuate the dominance of discourses around the hegemony of mathematics as the myth of 'certainty' (see Dowling, 1988, Chronaki, 2011, submitted). The myth of 'certainty' inscribes mathematics, even in such playful experiences, as a machine that enforces and enables the ruling and controlling of the world through regulating the capacities of ones' own body, mind and psyche within the borders and the affordances of certain acts, actions and activities (Walkerdine, 1988). Provided that the archetypes of play, games, gaming and playful experiences leave such myths and discourses untouched and without critique, they indulge into providing exemplary caveats of quite restrictive ways of experiencing mathematics merely as 'certainty' in a controllable universe.

As a way of conclusion

A first look at the idea of positioning mathematics with/in museums creates, at least, a sort of melancholic ambivalence. What is it that makes us feel nostalgic or discontent with 'mathematics' as a disciplinary area, as school subject or as a societal mathematising practice? And what is it that urges us to house mathematics with/in the museum? Historian Antonis Liakos refers to the harsh protest by Alexandros Papadiamantis, a national figure of literature who lived at the dawn of the 20th century, also known as Greece's Dostoevsky, in the occasion of utilizing an orthodox Christian icon as exhibit in the Byzantine and Christian Museum in Athens, who says:

> Και καθιδρύει [την εικόνα] όχι εις ναόν αλλ' εις Μουσείον, Ύψιστε Θεέ! Εις Μουσείον, ως να είχε παύσει να ασκείται εις τον τόπον τούτον η χριστιανική λατρεία, και τα σκεύη αυτής ν' ανήκον εις θαμμένον παρελθόν, και να ήσαν αντικείμενον περιεργείας (όπ. παρ. στο Νάκου, 2009: 38).
>
> And installs [the icon] not in the church but in the Museum, oh, Gracious Lord! In the Museum, as if the Christian faith has ceased to be practiced in this place, and its artefacts belong to the buried past, and they have become the object of curiosity (as quoted by Nakou, 2009: 38).

A trace of such melancholic ambivalence for the case of mathematics as an exhibit in Museums resorts into a very similar feeling of loss. Papadiamantis' protest urges us to pose questions as such: Is there any fear that mathematics, in a similar way as the icon for the Christian faith, will soon cease to be practiced in our local schools and communities? And even if it continues being processed in same routines, could children and adults be really interested and joyful into such tedious practices? Is mathematics a living organism or has mathematics been transformed into an object of the past, a disappearing object, that rises gazes of curiosity? Is this why any attempt for the installing of mathematics with/in museums attracts, currently, our attention and efforts?

Although, the above questions certainly demand a careful study taking into account that in contemporary capitalist society the exchange value of 'mathematics' for both the market and the employment sector has undergone significant changes. At the same time, mathematics has turned into a commodity desired and habited only by a few whilst the vast majority expresses sheer indifference or even negative affectivity. By and large, mathematics is being conceived as useful, joyful and approachable by only a marginal group –often described as nerds, weird or genius (Chronaki 2011, 2009). It is, thus, tempting to ask who might be those few who desire mathematics and around what mathematical subjectivities they become fabricated as subjects in our modern times. Towards this, the three cases of 'mathematics with/in the museum' discussed above might enable us to provide some preliminary thoughts.

To start with, one needs to consider that not only mathematics, but also museums, schools, education and learning undergo the need for serious reconceptualization and restructuring in contemporary societies worldwide. The economic crisis, as a symptom in a wider sociopolital and sociocultural terrain, has created the conditions to interrogate what is 'knowledge', including mathematical knowledge, and what might be its current status in the workplace of a market free economy. In this context, museums strive to survive as institutions; mathematics faces the demands for cultural renewal so that to become accessible to a wider public; technology, digital media and programming create the context for mathematics to remain hidden through the code; children and families reconsider the role of the school as the main place for learning; adolescents become more and more indifferent into pursuing mathematical careers; teachers face the dilemmas of teaching at times of economic crisis and, at many cases, extreme poverty. It seems, that such economic and socio-political parameters create conflictual circumstances for the housing of mathematics and mathematics education with/in the museum space. But, what does this housing might signify for mathematics itself and how does it unfold? What do these exemplary cases of museum mathematics, as discussed above, might provoke us to think?

Considering the three cases of hosting mathematics in three distinct museums located

in the three metropolis of London, Paris and New York could work out for shedding some light into how this alternative housing of mathematics unfolds and what its significance for a potential cultural renewal of mathematical objects, mathematising practices and mathematical subjectivities could be. Through these three cases, two important interrelated issues can be pointed out; *the first* is related with the realization that the ways mathematics becomes housed with/in the museum consists a complex assemblage of exhibits, displays, exhibitions, activities in the museum along with discourses about the role of mathematics and mathematising, and *the second* is related with the appreciation of any mathematical housing as an affective experience per se.

The Topology exhibition in Tate Modern assembles a number of events that consist a transdisciplinary dialogue of mathematics as part of social, philosophical, scientific and artistic practices, mathematics becomes a vibrant entity that lives, breathes and transforms through meeting and encountering 'other' disciplinary fields. Through these sensual experiences, mathematical language potentially grows, extents and expands into unintended and fortuitous genres. These novel genres involve the body, gestures, gesturing, senses and sensing into creating a space of aesthetics for mathematics, philosophy, arts and psychosocial theory. The Tate Modern and its reputation as an avant-garde centre of the world, located at the heart of London, has managed to embrace and carry through the risky endeavour of provoking a sensual and aesthetic conception of space, spatiality and of mathematics by means of opening up the field of topology.

In addition, the MoMath museum in New York also focuses on affectivity as it provides exhibits, displays and collections of artefacts that aim to involve the body, the hands, the senses and their extension through varied digitized experiences. However, the MoMath assemblage of events creates a very different affective and conceptual experience. Their difference is found in the style each of these two museums dialogues with discourses related to mathematics and mathematising. From a very first interpretation, based on the virtual experience of these two cases of museum mathematics, it is useful to denote that while the Tate Modern emphasizes an attempt to approach and value mathematics along with other fields of knowing, the MoMath museum focuses on unravelling the significance of mathematical tools in order to control specific haptic and digital media. Specifically, in Tate Modern mathematics becomes an aesthetic experience where science and arts become blurred, whilst in the MoMath mathematics turns into a playful experience where mathematics is the tool for particular scientific and artistic constructions. One could argue that whilst Tate Modern is geared towards creating a dialogic relation amongst and across varied disciplinary boundaries at the expense of risking mathematical language as a non-teleological process, the MoMath celebrates the kudos of mathematical knowledge and knowing.

On the other hand, the Musée de l' Homme has come to host the idea of mathematics as mathematising only at a time when the Sara Baartman's body became highly politicized especially by feminist and postcolonial protests. It is important to indicate that this particular museum display was not created with the intention of becoming an exhibit of museum mathematics. In fact, it had remained buried within the museum, was made silent for many decades and was of no interest for the circles of mathematical sciences until feminist activism exposed 'her story' as a story that matters for science. This particular museum exhibit, although not built purposefully to serve the needs for mathematics or, even, mathematics education, its political discussion as an object of mathematising exemplified the hazards, perils and exposures of a supposedly value free, yet functional use of mathematical applications subjected to 'scientific gaze'.

The function of a supposedly neutral mathematising procedure implemented on the female black body has served both to constitute 'science', and in particular the discipline of 'mathematics' as the main and only valid toolkit for scientific inquiry. This very practice has served to shape science as the discipline of systematic order and to dismantle not only the body of a woman or the body of Africa, but also the body of the scientific culture itself. Indeed, the museum display of Sara Baartman's body has proved a symbolic connotation for theorizing ethical and epistemological issues related to the established status of 'scientific evidence' around particular uses of empirical data or specific practices of observation and measuring techniques that came to consist what we know as modern 'scientific method' (Chronaki, 2009, 2010). As a final remark, it is important to note that these three cases compose three distinct approaches of how the idea of mathematics could be hosted in the museum, and, in turn, create distinct effects on how mathematics, mathematical learning and mathematical subjectivities become potentially and virtually fabricated with/in the museum space and materiality.

References

Agovino, T. (2014). "Math Museum multiplies and prospers", *Crain's New York Business*. March 3rd. URL: http://www. crainsnewyork.com/article/20140303/ARTS/140309984/ math-museum-multiplies-and-prospers#. Retrieved on 5 May 2015.

Behseta, S. & Dunn, M. (2015). "A peek into MoMath", *Chance*, 28(1). URL: http://chance.amstat.org/2015/02/momath/ Retrieved on 5 May 2015.

Chronaki, A. (submitted, in Greek). A critique on the hegemony of an ideology of certainty in mathematics and mathematics education.

Chronaki, A. (2011). *Disrupting development as the quality/equity discourse: Cyborgs and subalterns in school technoscience*. In B. Atweh, M. Graven, W. Secada & P. Valero (Eds.). *Mapping Equity and Quality in Mathematics Education* (pp. 3-21). Dordrecht: Springer.

Chronaki, A. (2010). Revisiting mathemacy: A process-reading of critical mathematics education. In Alrø, H., Ravn, O. & Valero, P. (Eds.), *Critical Mathematics Education: Past, Present, and Future: Festschrift for Ole Skovsmose* (pp. 31-49). Rotterdam: Sense Publishers.

Chronaki, A. (2009). *Mathematics, Technologies, Education: The Gender Perspective*. Volos. University of Thessaly Press.

Dowling, P. (1988). The Sociology of Mathematics Education. London. Falmer Press.

Clough, P. T. (2008). "The affective turn : Political economy, biomedia and bodies", *Theory Culture Society* 25(1), 1-22.

Deleuze, G. (1995). *Negotiations 1972-1990.* (Translated by Martin Joughin). New York: Columbia University Press.

De Freitas, E. & Sinclair, N. (2014). *Mathematics and the body: Material entanglements in the classroom*. New York: Cambridge University Press.

Ellis, H. (1926). *Man and woman: A study of secondary sexual characters*. London: A & C. Black.

Galton, Fr. (1853). *Narrative of an Explorer in South Africa*. London.

Gould, S.J. (1981). *The Mismeasure of Man*. New York: W.W. Norton.

Hansen, M. (2004a). *New Philosophy for New Media*. Cambridge, MA: MIT Press.

Hansen, M. (2004b). "The time of affect, or bearing witness to life", *Critical Inquiry* 30(spring), 584–626.

Hine, C.M. (2000). Virtual Ethnography. Thousand Oaks. CA: Sage Publications Ltd.

Jablonka, E. (2010). Reflections on mathematical modelling. In H. Alrø, O. Ravn, P. Valero (Eds.) *Critical Mathematics Education: Past, Present, and Future: Festschrift for Ole Skovsmose* (pp. 89-100). Rotterdam: Sense Publishers.

Jones, L. (Ed.) (1991). *Teaching Mathematics and the Art*. Cheltenham: Stanley Thornes.

Massumi, B. (2002). *Parables for the Virtual*. Durham, NC: Duke University Press.

Nakou, I. (2009). *Moussia, istories ke Istoria [Mouseums, histories and History]*. Athens: nissos.

Nakou, I. (2001). *Moussia: Emis, ta Pragmata ke o Politismos [Mouseums: We All, Objects and Culture]*. Athens: Nissos.

Qureshi, S. (2004). "Displaying Sara Baartman, the 'Hottentot Venus'", *History of Science* 42, 233–57.

Restivo, S. (2009). Minds, morals, and mathematics in the wake of the deaths of Plato and God: Reflections on what social constructionism means, really. In A. Chronaki (Ed.). *Mathematics, Technologies, Education: The Gender Perspective*. (pp. 37-43). Volos, Greece: University of Thessaly Press.

Rotman, B. (1979). *Mathematics: An Essay in Semiotics*. Bristol: University of Bristol, mimeo.

Rotman, B. (2000). *Mathematics as Sign. Writing, Imagining, Counting*. Stanford: Stanford University Press.

Said, E. W. (1978*). Orientalism*. New York: Pantheon.

Stepan, N. (2000). Race and gender: The role of analogy in science. In G. Kirkup, L. James, K. Woodward & F. Hovenden (Eds.). *The Gendered Cyborg: A Reader* (pp. 38-49). London: Routledge and Open University Press.

Schiebinger, L. (2000). Taxonomy for human beings. In G. Kirkup, L. James, K. Woodward & F. Hovenden (Eds.). *The Gendered Cyborg: A Reader* (pp. 11-38). London. Routledge and Open University Press.

Short, D. & Peters, A. (2014). "The Museum of Mathematics (MOMATH) - The next generation of science museum", *Mathematics Teaching*, 242. Report published on September 2014 on Association of Teachers of Mathematics' website: URL: http://www.atm.org.uk/write/Media_Uploads/Journals/MT242-14-05.pdf Retrieved on 5 May 2015.

Topology. 2011-2012. *Topology at Tate Modern. Exhibition Catalogue*. London: Tate.

Wallis, D. (2014) "Start-up success isn't enough to found a museum", *New York Times*. URL: http://www.nytimes. com/2014/03/20/arts/artsspecial/start-up-success-isntenough-to-found-a-museum.html?_r=0 Retrieved on 5 May 2015.

Walkerdine, V. (1988). Counting Girls Out: Girls and Mathematics. London. Falmer Press.

List of Pictures (with reference to their URL)

Picture 1. Tate Modern, Bankside London. Retrieved in May 2015 from: http://www.maa.org/sites/default/files/images/upload_library/46/1/old_convergence/Paoletti/Figure-2-perchance.png

Picture 2. Tate Modern. The extension. Retrieved in May 2015 from: https://neonwatty.files. wordpress.com/2012/08/mobius.jpg

Picture 3. The Seven Bridges of Konisberg. Retrieved in May 2015 from: http://www.gold.ac.uk/media/topology.jpg

Picture 4. The Mobious Strip. Retrieved in May 2015 from: http://www.e-flux.com/wp-content/uploads/2012/01/5b929_jan11_tate.jpg?b8c429

Picture 5. Topology turned into Art. Retrieved in May 2015 from: http://3.bp.blogspot.com/-dIBG_Uh298o/T5Tzi5xqvyI/AAAAAAAABZo/gjt_mGohNbM/s320/IMG_2240.jpg

Picture 6. Topology turned into Art. Retrieved in May 2015 from: http://www.ams.org/mathimagery/albums/userpics/10002/segerman-roundmobius-12.jpg

Picture 7. Topology Exhibition. Retrieved in May 2015 from: http://www.gold.ac.uk/media/topology.jpg

Picture 8. Routes. Retrieved in May 2015 from: http://www.e-flux.com/wp-content/uploads/2012/01/5b929_jan11_tate.jpg?b8c429

Picture 9. Borders. Retrieved in May 2015 from: http://images.tate.org.uk/sites/default/files/styles/grid-normal-8-cols/public/images/image/toplology-event.jpg?itok=6FP3TxI9

Picture 10. In-Between. Retrieved in May 2015 from: http://images.tate.org.uk/sites/default/files/styles/enlarged/public/images/embodying%20transformation%20event%20ordinal%205.jpg?itok=Ppnri_We

Picture 11. Sarah Baartman's body. Retrieved in May 2015 from: https://i1.wp.com/zar.co.za/images/bio/baartman/saartjie.jpg

Picture 12. Musée de l'Homme in Paris. Retrieved in May 2015 from: http://modules.quaibranly.fr/e-malette2/public/medias/lexique/musee_homme.png

Picture 13. The body at the services of the Scientist. Retrieved in May 2015 from: https://i1.wp.com/jamaicatakeout.com/wp-content/uploads/2015/02/Sarah-Bartman-life-examples.jpg

Picture 14. Hottentot Venus in Display. Retrieved in May 2015 from: http://rogovoy.com/images/Hottentot-Venus-MASS-MoCA-Seth-Rogovoy.jpg

Picture 15. Hottentot Venus in Display. Retrieved in May 2015 from: http://zar.co.za/images/bio/baartman/baartman9.jpg

Picture 16. Caricature of the scientific gaze upon Sara Baartman. Retrieved in May 2015 from: http://upload.wikimedia.org/wikipedia/commons/8/87/La_Belle_Hottentot.jpg

Picture 17. Momath, Manhattan, New York. Retrieved in May 2015 from: https://exhibitdev.files.wordpress.com/2013/01/momath01.png?w=500&h=333

Picture 18. Momath, Manhattan, New York. Retrieved in May 2015 from: https://nyoobserver.files.wordpress.com/2012/01/momath.jpg

Picture 19. The square-wheeled bicycle. Retrieved in May 2015 from: http://www.sciencethrillers.com/wp-content/uploads/momath2.jpg

Picture 20. The square-wheeled bicycle. Retrieved in May 2015 from: https://redtricom.files.wordpress.com/2013/07/momath-trike-e1374674781701.jpg?w=600

Picture 21. Tessellations and Escher patterns. Retrieved in May 2015 from: http://momath.org/wp-content/gallery/main-gallery/img_3360.jpg

Picture 22. Tessellations and Escher patterns. Retrieved in May 2015 from: http://kids.baristanet.com/files/2012/12/momath.jpg

Picture 23. Full Body Interactive Games. Retrieved in May 2015 from: http://i.ytimg.com/vi/qeOW8Umr0Hk/maxresdefault.jpg

Picture 24. Full Body Interactive Games. Retrieved in May 2015 from: https://in.momath.org/sites/default/files/civicrm/persist/contribute/images/photo%201(1).JPG

Picture 25. Interactive Installation. Retrieved in May 2015 from: *http://blogs.scientificamerican.com/observations/files/2012/12/hyperhyperboloid.jpg*

Endnotes

[1] The methodology employed for this study is based on a virtual ethnography approach (i.e. a process of conducting an ethnography using the online resources and sites provided in the worldwideweb). Data collection has involved the locating of information such as pictures, videos, websites and papers archived in the internet with a focus on those digital material that have been utilised as part of the three online museum sites, their related sources and their virtual representations. Following Hine (2000) who describes the internet as a place of both conducting social interactions and becoming the product of those interactions, the online presentations of these three case studies discussed here can be conceived as active performance spaces. Despite the limits and limitations of virtual ethnography, as compared to an anthropological ethnography where physical presence and immersion in the field is emphasized, it is, today, amongst the most useful methods for tapping particular communities where access is not possible within the available spatial and temporal circumstances.

[2] Quoting from Wikipedia '*A natural number (which, in this context, includes the number 0) can be used for two purposes: to describe the size of a set, or to describe the position of an element in a sequence. When restricted to finite sets these two concepts coincide; there is only one way to put a finite set into a linear sequence, up to isomorphism. When dealing with infinite sets one has to distinguish between the notion of size, which leads to cardinal numbers, and the notion of position, which is generalized by the ordinal numbers described here. This is because, while any set has only one size (its cardinality), there are many non-isomorphic well-orderings of any infinite set […]*' Retrieved in May 2015 from: http://en.wikipedia.org/wiki/Ordinal_number

[3] Quoting from Wikipedia '*In mathematics, the Borromean rings consist of three topological circles which are linked and form a Brunnian link (i.e., removing any ring results in two unlinked rings)*' Retrieved in May 2015 from: http://en.wikipedia.org/wiki/Borromean_rings

[4] Julian Henriques explain more about acoustic geometries in the video entitled Sound Reasons. Retrieved in May 2015 from: https://www.youtube.com/watch?v=Ra_zF0NVHWA

[5] Steatopygia refers to the extraordinary concentration of fat in specific parts of the body. Retrieved in May 2015 from: http://en.wikipedia.org/wiki/Steatopygia

[6] Sir Francis Galton (1822 – 1911) was a British polymath explorer, eugenist, geographer, proto-genetist and early statistician and psychologist amongst other specializations who wrote extensively about Africa (see Galton, 1853).

[7] It was reported that in 2013, just one year after its opening, MoMath had 173.255 visitors, with a projected 90.000 for 2014 (see Agovino 2014, Wallis 2014).

[8] Retrieved in May 2015 from: https://www.simonsfoundation.org/

[9] Chance. Peek of the Month (see http://chance.amstat.org/2015/02/momath/).

[10] Marissa Fessenden (2012) writes in Scientific American '*In the striking "Hyper Hyperboloid" exhibit, coloured cords extending from ground to ceiling surround a chair. Nissen demonstrates how visitors can enter the shape, spin in the chair and watch the cords swivel and form a curved surface around them*' [http://blogs.scientificamerican.com/observations/please-play-with-your-math-new-museum-opens-in-new-york-city/].